Control Devices CDJ CANopen

User Manual

Revision 1.3

22/10/2013

Control Devices

Joysticks • Control Grips • Sensors • Encoders • Custom Electronics

Unit 5, 79 Bourke Road, Alexandria NSW 2015 Australia, Phone +61 2 9330 1700 Fax: +61 2 8338 9001

E-mail: sales@controldevices.net Visit: www.controldevices.net

Contents

1 Revision Table 4
2 Definition of Terms 4
3 General Description 5
4 Features 5
5 Electrical Connection 6
6 Recommended Operating Conditions 7
7 Absolute Maximum Ratings 7
8 Device Configuration 8
8.1 SW1: Baud Rate Configuration 8
8.2 SW2: Node Identifier Configuration 9
8.3 SW3: Termination Resistor Configuration 9
8.4 J1 to J4: Disable Analogue Input 9
8.5 J5 to J7: Memory Mode 10
8.6 J8: Operation Mode 10
9 Object Dictionary 10
9.1 Service Data Objects 10
9.1.1 Index 0x0005, 0x0006x and 0x0007: Dummy Objects 10
9.1.2 Index 0x1001: Error Register 11
9.1.3 Index 0x1002: Status Register 11
9.1.4 Index 0x1008: Device Name 11
9.1.5 Index 0x100C: Guard Time 11
9.1.6 Index 0x100D: Life Time Factor 12
9.1.7 Index 0x100E: Node Guarding and Heartbeat Object ID 12
9.1.8 Index 0x1010: Save Parameters 12
9.1.9 Index 0x1011: Load Default Parameters 13
9.1.10 Index 0x1014: Emergency Message Object ID 13
9.1.11 Index 0x1015: Emergency Message Inhibit Time 13
9.1.12 Index 0x1017: Heartbeat Time 14
9.1.13 Index 0x2180: CAN Restart Time 14
9.2 Process Data Objects 14
9.2.1 Communication Parameter Objects 14

Unit 5, 79 Bourke Road, Alexandria NSW 2015 Australia Phone +61 2 9330 1700 Fax: +61 2 8338 9001
E-mail: sales@controldevices.net Visit: www.controldevices.net

9.2.2 PDO Mapping Objects 16
9.3 Digital Output Objects 17
9.3.1 Index 0x6200: Write Digital Output 17
9.3.2 Index 0x6202: Polarity Mask 18
9.3.3 Index 0x6206: Error Mode Enable 18
9.3.4 Index 0x6207: Error Mode Output Value 18
9.4 Digital Input Objects 19
9.4.1 Index 0x5003: Debounce Time 19
9.4.2 Index 0x6000: Read Digital Input 20
9.4.3 Index 0x6005: Global Interrupt Enable 20
9.4.4 Index 0x6006: Interrupt Mask: Any Change 21
9.4.5 Index 0x6007: Interrupt Mask: Rising Edge 21
9.4.6 Index 0x6008: Interrupt Mask: Falling Edge 21
9.5 Analogue Input Objects 21
9.5.1 Index 0x5401: Dead Band Value 21
9.5.2 Index 0x6401: Read Analogue Input 22
9.5.3 Index 0x6421: Interrupt Trigger Type 23
9.5.4 Index 0x6423: Global Interrupt Enable 23
9.5.5 Index 0x6424 to 0x6428: Interrupt Limits 24
9.5.6 Index 0x6431: Input Offset 24
10 Emergency Messages 24
11 Example Usage Scenarios 25
11.1 Default Settings 25
11.2 Send Message on Change 26
11.3 Send Message on Change and Periodically 26
11.4 Send Message on Remote Transmission Request 27
11.5 Send Message on Sync Signal 27

Unit 5, 79 Bourke Road, Alexandria NSW 2015 Australia Phone +61 2 9330 1700 Fax: +61 2 8338 9001
E-mail: sales@controldevices.net Visit: www.controldevices.net

1 Revision Table

Revision	Date	Comment
1.0	19/04/2012	Document issued.
1.1	25/05/2012	Corrected formatting, added M12 connector.
1.2	08/10/2013	Corrected pin allocation on M12 connector.

2 Definition of Terms

ms	Millisecond, 0.001 seconds
µs	Microsecond, 0.000001 seconds
Tx	Transmit
Rx	Receive
PDO	Process Data Object
COB ID	CAN Object Identifier
NMT	Network Management message
EMCY	Emergency message
SYNC	Sync message
RTR	Remote Transmission Request
0b	Prefix to denote a binary number
0x	Prefix to denote a hexadecimal number

Unit 5, 79 Bourke Road, Alexandria NSW 2015 Australia Phone +61 2 9330 1700 Fax: +61 2 8338 9001
E-mail: sales@controldevices.net Visit: www.controldevices.net

3 General Description

The Control Devices CDJ CANopen is a multi-axis potentiometer joystick controller with CANopen output. The joystick offers the same compact size, strength and reliability as the Penny + Giles JC6000 and is available in one or two axis configuration with all handle options available on the standard Penny + Giles JC6000.

4 Features

- Long life potentiometer track
- Single or dual axis
- High strength lever with superb proportional control
- Configurable with all handle options available on Penny + Giles JC6000
- Custom handles can be designed with up to 20 digital inputs, 4 proportional axes (including the joystick axes) and 4 digital outputs (up to 4 mA)
- 10 bit resolution of proportional axes
- Centre on and directional switches for each axis (directional switches consume a general purpose digital input)
- Memory function to freeze axis position on button input
- IP68 sealed connector
- Electrically isolated – power supply input can withstand 1.5kV transient voltage and CAN transceiver lines can withstand 5kV transient voltage.

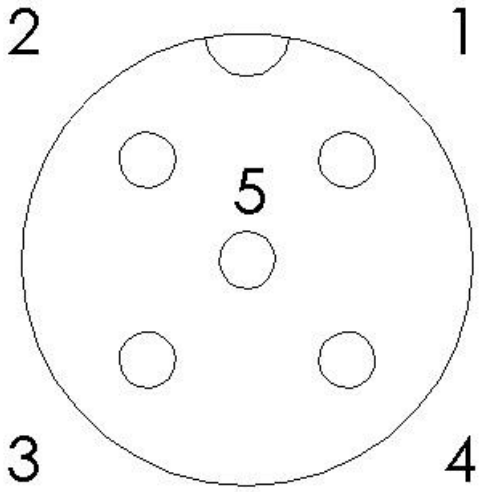
Unit 5, 79 Bourke Road, Alexandria NSW 2015 Australia Phone +61 2 9330 1700 Fax: +61 2 8338 9001
E-mail: sales@controldevices.net Visit: www.controldevices.net

5 Electrical Connection

The joystick is available with a 5 pin M12 connector or a 4 pin Bulgin PX0413/04P 400 Series Buccaneer plug connector.

5.1 M12 5 pin Connector

The M12 plug connector mates with M12 socket connectors. The figure below shows the connector as viewed from the bottom of the joystick.



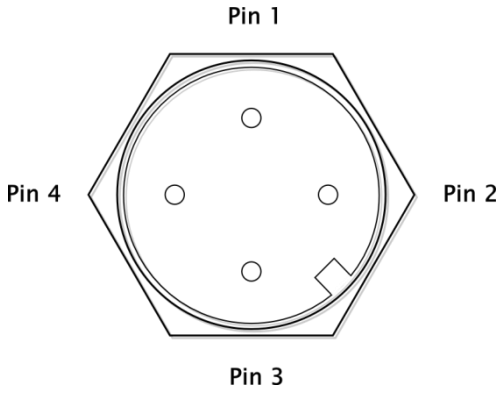
Pin	Function
1	CAN SHIELD
2	CAN +V
3	CAN GND
4	CAN H
5	CAN L

Refer to technical drawings supplied with joystick for more information.

Unit 5, 79 Bourke Road, Alexandria NSW 2015 Australia Phone +61 2 9330 1700 Fax: +61 2 8338 9001
E-mail: sales@controldevices.net Visit: www.controldevices.net

5.2 4 pin Bulgin PX0413/04P

The 4 pin Bulgin PX0413/04P 400 Series Buccaneer plug connector mates with socket connectors PX0410/S, PX0400/S or PX0402/S. The figure below shows the connector as viewed from the bottom of the joystick.



Pin	Function
1	+24 V Power
2	0 V GND
3	CANH
4	CANL

Refer to technical drawings supplier with joystick for more information.

6 Recommended Operating Conditions

	Min	Typical	Maximum
Power Supply Voltage	18 V	24 V	36 V
Power Supply Current		30 mA	40 mA
CAN H Input Voltage	4 V		5.3 V
CAN H Output Voltage	4.5 V		
CAN L Input Voltage	-0.3 V		1 V
CAN L Output Voltage			0.4 V
Operating Temperature	-40°C		+85°C

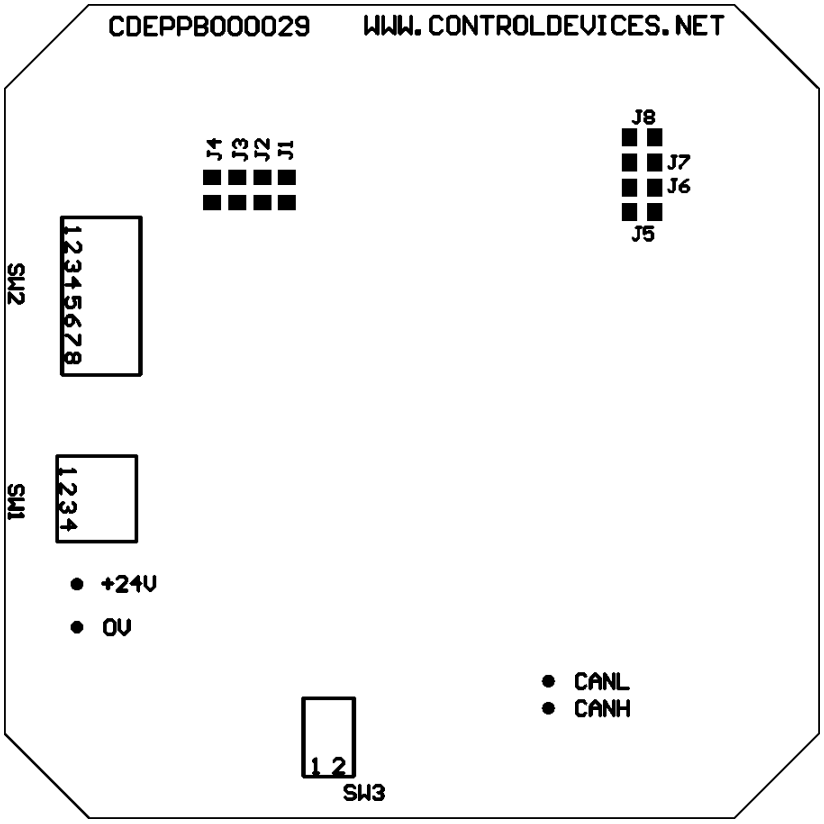
7 Absolute Maximum Ratings

	Minimum	Maximum
Power Supply Voltage		40 V
CAN Input Voltage	-0.3 V	6 V
CAN Output Voltage	-0.3 V	6 V
CAN Output Current (Time < 20 ms)		15 mA
CAN Output Current		4 mA
General Purpose Output Current (Time < 20 ms)		15 mA
General Purpose Output Current		4 mA

Unit 5, 79 Bourke Road, Alexandria NSW 2015 Australia Phone +61 2 9330 1700 Fax: +61 2 8338 9001
E-mail: sales@controldevices.net Visit: www.controldevices.net

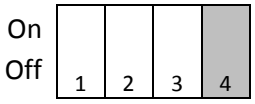
8 Device Configuration

Three DIP switch banks and two jumper banks provide hardware configuration of the joystick.



8.1 SW1: Baud Rate Configuration

DIP switch bank SW1 provides baud rate selection. Switch 4 is unused.

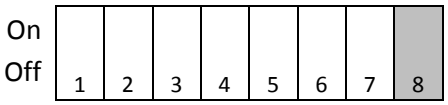


Baud Rate	Switch 1	Switch 2	Switch 3
1 Mbit/sec	OFF	OFF	OFF
800 kbit/sec	ON	OFF	OFF
500 kbit/sec	OFF	ON	OFF
250 kbit/sec	ON	ON	OFF
125 kbit/sec	OFF	OFF	ON
50 kbit/sec	ON	OFF	ON
20 kbit/sec	OFF	ON	ON
10 kbit/sec	ON	ON	ON

Unit 5, 79 Bourke Road, Alexandria NSW 2015 Australia Phone +61 2 9330 1700 Fax: +61 2 8338 9001
E-mail: sales@controldevices.net Visit: www.controldevices.net

8.2 SW2: Node Identifier Configuration

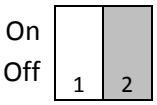
DIP switch bank SW2 configures the node identifier. The switch bank represents a 7-bit binary number, with switch 1 as the least significant bit and switch 7 as the most significant bit. Switch 8 is unused.



Node Identifier	Switch 7	Switch 6	Switch 5	Switch 4	Switch 3	Switch 2	Switch 1
Reserved	OFF	OFF	OFF	OFF	OFF	OFF	OFF
1	OFF	OFF	OFF	OFF	OFF	OFF	ON
2	OFF	OFF	OFF	OFF	OFF	ON	OFF
…							
126	ON	ON	ON	ON	ON	ON	OFF
127	ON	ON	ON	ON	ON	ON	ON

8.3 SW3: Termination Resistor Configuration

SW3 enables a 120 Ω resistor across the CAN data lines to electrically terminate the network. The resistor should be enabled if the device is at the end of the bus. Switch 2 is unused.



Function	Switch 1
Resistor disabled	OFF
Resistor enabled	ON

8.4 J1 to J4: Disable Analogue Input

These jumpers are used to disable unused analogue axes.

Jumper	Axis
1	X
2	Y
3	Z
4	W

Refer to the additional sheet for information specific to your joystick configuration.

Unit 5, 79 Bourke Road, Alexandria NSW 2015 Australia Phone +61 2 9330 1700 Fax: +61 2 8338 9001
E-mail: sales@controldevices.net Visit: www.controldevices.net

8.5 J5 to J7: Memory Mode

These jumpers are used to define the memory function of the device, which allows digital inputs to freeze the analogue input value.

Jumper			Memory Mode	Description
J7	J6	J5		
1	1	1	0	Push button input memory function with internal analogue value freeze.
1	1	0	1	Push button input memory function without internal analogue value freeze.
1	0	1	2	Switch input memory function with internal analogue value freeze.
1	0	0	3	Switch input memory function without internal analogue value freeze.
0	1	1	4	Memory function disabled.

Refer to the additional sheet for information on the memory function specific to your joystick configuration.

8.6 J8: Operation Mode

This jumper should be enabled for normal operation of the device. Disabling this jumper will enable a “special CAN features” mode provided for legacy systems that does not conform to the CANopen specification.

9 Object Dictionary

9.1 Service Data Objects

9.1.1 Index 0x0005, 0x0006x and 0x0007: Dummy Objects

These objects are implemented to allow reservation of data space in PDOs by mapping to dummy entries.

Name	Index	Sub-index	Data Type	Access	PDO Mapping	Default Value
Dummy 8	0x0005	0	Unsigned 8	RO	Yes	0
Dummy 16	0x0006	0	Unsigned 16	RO	Yes	0
Dummy 32	0x0007	0	Unsigned 32	RO	Yes	0

Unit 5, 79 Bourke Road, Alexandria NSW 2015 Australia Phone +61 2 9330 1700 Fax: +61 2 8338 9001
E-mail: sales@controldevices.net Visit: www.controldevices.net

9.1.2 Index 0x1001: Error Register

This object indicates an error in the device.

Name	Index	Sub-index	Data Type	Access	PDO Mapping	Default Value
Error Register	0x1001	0	Unsigned 8	RO	Yes	-

An error is communicated by active bits; the error register bits have the following meaning:

Bit	Meaning
0	Generic error. This bit is set if any error is active.
4	CAN bus or communication error.
7	Device Error.

9.1.3 Index 0x1002: Status Register

This object indicates the status of the device

Name	Index	Sub-index	Data Type	Access	PDO Mapping	Default Value
Status Register	0x1002	0	Unsigned 32	RO	Yes	-

The device status is communicated by an active bit; the status register bits have the following meaning:

Bit	Meaning
30	Node guarding error.
31	The device is operational.

9.1.4 Index 0x1008: Device Name

This object holds the name of the device.

Name	Index	Sub-index	Data Type	Access	PDO Mapping	Default Value
Device Name	0x1008	0	String	RO	No	-

9.1.5 Index 0x100C: Guard Time

This object defines the Guard Time used for Node Guarding. The value of the object is a multiple of 1 ms, a value of 0 will disable Node Guarding. The device can use either Heartbeat or Node Guarding; do not use both protocols at the same time.

Name	Index	Sub-index	Data Type	Access	PDO Mapping	Default Value
Guard Time	0x100C	0	Unsigned 16	RW	No	0

Unit 5, 79 Bourke Road, Alexandria NSW 2015 Australia Phone +61 2 9330 1700 Fax: +61 2 8338 9001
E-mail: sales@controldevices.net Visit: www.controldevices.net

9.1.6 Index 0x100D: Life Time Factor

The Life Time Factor, multiplied by the Guard Time is used to determine the Life Time in milliseconds when Node Guarding is used. A value of 0 will disable Node Guarding.

Name	Index	Sub-index	Data Type	Access	PDO Mapping	Default Value
Life Time Factor	0x100D	0	Unsigned 16	RW	No	0

9.1.7 Index 0x100E: Node Guarding and Heartbeat Object ID

This object holds the identifier of the CAN object for the node guarding and heartbeat protocol. By default it is the node ID added to 0x700.

Name	Index	Sub-index	Data Type	Access	PDO Mapping	Default Value
Guard COB ID	0x100E	0	Unsigned 32	RW	No	0x700 + Node ID

9.1.8 Index 0x1010: Save Parameters

This object is used to store modifications to the device's configuration in non-volatile memory so that the configuration is maintained after the device restarts. This function is only available in pre-operational mode.

Name	Index	Sub-index	Data Type	Access	PDO Mapping	Default Value
Save Parameters	0x1010	1	Unsigned 32	RW	No	-

To use this function the register must be written with a signature value, the value is the word "save".

	MSB			LSB
ASCII	e	v	a	s
Hexadecimal	0x65	0x76	0x61	0x73
	0x65766173			
Decimal	1702257011			

Unit 5, 79 Bourke Road, Alexandria NSW 2015 Australia Phone +61 2 9330 1700 Fax: +61 2 8338 9001
E-mail: sales@controldevices.net Visit: www.controldevices.net

9.1.9 Index 0x1011: Load Default Parameters

This object is used to restore the factory default parameters of the device. Note that this is the factory default settings of the microcontroller used for CANopen communication and may differ from the original settings that were provided with the joystick. This function is only available in pre-operational mode. After executing this function the device must be rest either by cycling the power or executing the NMT reset command. Once the device has booted the default configuration will be in use, however it will not be saved and therefore on subsequent resets the device will revert back to its last saved configuration. To save the configuration after loading default parameters see *9.1.8 Index 0x1010: Save Parameters.*

Name	Index	Sub-index	Data Type	Access	PDO Mapping	Default Value
Load Default Parameters	0x1011	1	Unsigned 32	RW	No	-

To use this function the register must be written with a signature value, the value is the word “load”.

	MSB			LSB
ASCII	d	a	o	l
Hexadecimal	0x64	0x61	0x6f	0x6c
	0x64616f6c			
Decimal	1684107116			

9.1.10 Index 0x1014: Emergency Message Object ID

This object holds the identifier for CAN emergency messages. By default it is the node ID added to 0x80.

Name	Index	Sub-index	Data Type	Access	PDO Mapping	Default Value
EMCY COB ID	0x1014	0	Unsigned 32	RW	No	0x80 + Node ID

9.1.11 Index 0x1015: Emergency Message Inhibit Time

This object defines the inhibit time for emergency messages; the minimum duration before a new emergency message can be sent. The value of the object is a multiple of 100 µs however the device only offers a resolution of 1 ms. A value of 0 in this object disables the inhibit time for emergency messages.

Name	Index	Sub-index	Data Type	Access	PDO Mapping	Default Value
EMCY Inhibit Time	0x1015	0	Unsigned 16	RW	No	0

Unit 5, 79 Bourke Road, Alexandria NSW 2015 Australia Phone +61 2 9330 1700 Fax: +61 2 8338 9001
E-mail: sales@controldevices.net Visit: www.controldevices.net

9.1.12 Index 0x1017: Heartbeat Time

This object defines the time between NMT heartbeat messages. The value of the object is a multiple of 1 ms, a value of 0 disables the heartbeat producer. The device can use either heartbeat or node guarding, do not use both protocols at the same time.

Name	Index	Sub-index	Data Type	Access	PDO Mapping	Default Value
Heartbeat Time	0x1017	0	Unsigned 16	RW	No	0

9.1.13 Index 0x2180: CAN Restart Time

This object defines the restart timeout for the CAN communication layer when the device transitions to the Bus Off state. The value of the object is a multiple of 1 ms. A value of 0 in this object will disable automatic restart of the device in the case of a Bus Off error state.

Name	Index	Sub-index	Data Type	Access	PDO Mapping	Default Value
CAN Restart Time	0x2180	0	Unsigned 16	RW	No	0

9.2 Process Data Objects

9.2.1 Communication Parameter Objects

Each PDO has an array to define parameters. Three PDOs are used by the device and the locations of the parameter arrays are:

Index	PDO	Description
0x1400	RxPDO1	Digital Output PDO Parameters
0x1800	TxPDO1	Digital Input PDO Parameters
0x1801	TxPDO2	Analogue Input PDO Parameters

The arrays all contain the same objects and the sub-indexes are:

Name	Sub-index	Data Type	Access	PDO Mapping	Default Value
Largest Sub-index Supported	0	Unsigned 8	RO	No	5
CAN Object ID	1	Unsigned 32	RW	No	0x200 + Node ID
Transmission Type	2	Unsigned 8	RW	No	255
Inhibit Time	3	Unsigned 16	RW	No	0
Reserved	4	-	-	No	-
Event Time	5	Unsigned 16	RW	No	0

9.2.1.1 Sub-index 0: Largest Sub-index Supported

This object returns the number of objects in the structure.

Unit 5, 79 Bourke Road, Alexandria NSW 2015 Australia Phone +61 2 9330 1700 Fax: +61 2 8338 9001
E-mail: sales@controldevices.net Visit: www.controldevices.net

9.2.1.2 Sub-index 1: CAN Object ID

This object holds the object identifier for the PDO. By default it is the node ID added to 0x200.

9.2.1.3 Sub-index 2: Transmission Type

This object is used to define the transmission configuration for the PDO. The value of the object defines the transmission type:

Value	Type	Description
0	Acyclic Synchronous	Message is transmitted on the SYNC signal only if data has changed.
1 – 240	Cyclic Synchronous	Message is transmitted on the SYNC signal; the value represents the number of SYNC signals before a message is transmitted. A value of 1 will transmit a message on every SYNC signal, a value of 2 will transmit a message on every second SYNC signal… etc.
252	Synchronous RTR	Data is updated on the SYNC signal but message is only sent on the reception of a Remote Transmission Request.
253	Asynchronous RTR	Data is updated and message is sent on the reception of a Remote Transmission Request.
254	Asynchronous	CanEasy Mode for development. Message is transmitted immediately on any change, unless prohibited by Inhibit Time, and after Event Time.
255	Asynchronous	Message is transmitted immediately on any change, unless prohibited by Inhibit Time, and after Event Time. This transmission type should also be used for the receive PDO (the digital output).

9.2.1.4 Sub-index 3: Inhibit Time

This object defines the inhibit time for the PDO messages; the minimum duration before a new message can be sent. The value of the object is a multiple of 100 ms and a value of 0 in this object will disable the inhibit time for the PDO. This object has no effect on the receive PDO.

9.2.1.5 Sub-index 4: Reserved

This object is not used.

9.2.1.6 Sub-index 5: Event Time

This object defines the event time for the PDO messages; the duration before a new message is sent. This setting only applies to PDO transmission type 254 or 255 as defined in sub-index 2 of the PDO parameter structure. A value of 0 will disable the event timer. This object has no effect on the receive PDO.

Unit 5, 79 Bourke Road, Alexandria NSW 2015 Australia Phone +61 2 9330 1700 Fax: +61 2 8338 9001
E-mail: sales@controldevices.net Visit: www.controldevices.net

9.2.2 PDO Mapping Objects

PDO Mapping Objects allow any mappable global object to be delivered in a PDO message. Each PDO has a structure to define PDO Mapping, the location of these structures are:

Index	PDO	Description
0x1600	RxPDO1	Digital Output PDO Mapping Object
0x1A00	TxPDO1	Digital Input PDO Mapping Object
0x1A01	TxPDO2	Analogue Input PDO Mapping Object

The structures all have the same format. The first sub-index defines the number of mapped objects in the PDO; subsequent sub-indexes contain the mapped objects. When changing the mapping of a PDO, sub-index 0 must first be set to 0 to disable mapping, then set to the correct number of mapped objects after remapping is complete. A maximum of 8 mapped objects in each PDO is possible.

Name	Sub-index	Data Type	Access	PDO Mapping	Default Value
Number of Mapped Objects	0	Unsigned 8	RW	No	-
Mapped Object	1 to 8	Unsigned 32	RW	No	-

The Mapped Object sub-index is a 32 bit value that points to a mappable object. The structure of the sub-index is as follows:

MSB			LSB
Byte 3	**Byte 2**	**Byte 1**	**Byte 0**
Index of Mapped Object		Sub-index	Length

For example, to map the two joystick axis potentiometers into transmit PDO2 (the analogue input PDO) the PDO Mapping structure would be:

Index	Sub-index	Value	Comment
0x1a01	0	2	The structure contains two objects.
0x1a01	1	0x64010110	Maps to analogue input 1; index: 0x6401, sub-index: 0x01, which has a length of 16 bits.
0x1a01	2	0x64010210	Maps to analogue input 2; index: 0x6401, sub-index: 0x02, which has a length of 16 bits.

Unit 5, 79 Bourke Road, Alexandria NSW 2015 Australia Phone +61 2 9330 1700 Fax: +61 2 8338 9001
E-mail: sales@controldevices.net Visit: www.controldevices.net

Another example, mapping the joystick axis directional switches and two handle push buttons into transmit PDO1 (the digital input PDO) would be:

Index	Sub-index	Value	Comment
0x1a00	0	2	The structure contains two objects.
0x1a00	1	0x60000208	Maps to digital input byte 1; index: 0x6000, sub-index: 0x02, which has a length of 8 bits. The 8 bits of this object are defined by the input from up to 8 directional switches; the object is further explained in *9.4 Digital Input Objects.*
0x1a00	2	0x60000308	Maps to digital input byte 2; index: 0x6000, sub-index: 0x03, which has a length of 8 bits. The 8 bits of this object are defined by the input from up to 8 pushbuttons or switches; the object is further explained in *9.4 Digital Input Objects.*

All mappable objects, not just digital or analogue input or output, may be mapped into a PDO.

The factory default configuration maps 1 digital output object, 3 digital input objects and 2 analogue inputs into PDOs. Refer to the additional sheet for the location of inputs in the PDO for your joystick configuration.

9.3 Digital Output Objects

The following objects relate to the functionality of the digital outputs of the device, if used.

9.3.1 Index 0x6200: Write Digital Output

This array contains the object to control the digital output. The first sub-index returns the number of objects in the array, the second sub-index in the writable byte to control the 8 digital outputs. Output lines are active low, so a value of 1 in a bit of the output object represents a grounding of the output pin, and value of 0 will set the pin to high level. Before writing to the output ports the value of the bitmap is processed with *9.3.2 Index 0x6202: Polarity Mask* and inverted if necessary.

Refer to the additional sheet for the location of the digital output bits specific to your joystick configuration.

Name	Index	Sub-index	Data Type	Access	PDO Mapping	Default Value
Number of Objects in the Array	0x6200	0	Unsigned 8	RO	No	0x01
Write Digital Output	0x6200	1	Unsigned 8	WO	Yes	0

Refer to the additional sheet for the location of the digital output bits specific to your joystick configuration.

Unit 5, 79 Bourke Road, Alexandria NSW 2015 Australia Phone +61 2 9330 1700 Fax: +61 2 8338 9001
E-mail: sales@controldevices.net Visit: www.controldevices.net

9.3.2 Index 0x6202: Polarity Mask

This array contains an object to invert the digital outputs. When a change is made to the digital output object it is processed with the polarity mask and inverted if necessary. A value of 1 will invert the output bit.

Name	Index	Sub-index	Data Type	Access	PDO Mapping	Default Value
Number of Objects in the Array	0x6202	0	Unsigned 8	RO	No	0x01
Polarity Mask	0x6202	1	Unsigned 8	RW	No	0

Refer to the additional sheet for the location of the digital output bits specific to your joystick configuration.

9.3.3 Index 0x6206: Error Mode Enable

The device has a facility to set the digital outputs into a predefined state in the event of an error. This array contains an object to enable the error mode function for each digital output line. A value of 1 will enable the error mode function, by default it is enabled for all outputs.

Name	Index	Sub-index	Data Type	Access	PDO Mapping	Default Value
Number of Objects in the Array	0x6206	0	Unsigned 8	RO	No	0x01
Error Mode Enable	0x6206	1	Unsigned 8	RW	No	0xff

Refer to the additional sheet for the location of the digital output bits specific to your joystick configuration.

9.3.4 Index 0x6207: Error Mode Output Value

This array contains an object that defines the value of the digital output object in the event of an error. The value of each bit will be applied to any output line that has been enabled by *9.3.3 Index 0x6206: Error Mode Enable*. A value of 1 will force the output to active (output level low) in the event of an error, and value of 0 will force the output to inactive (output level high.) By default all outputs will be forced to inactive.

Name	Index	Sub-index	Data Type	Access	PDO Mapping	Default Value
Number of Objects in the Array	0x6207	0	Unsigned 8	RO	No	0x01
Error Mode Output Value	0x6207	1	Unsigned 8	RW	No	0x00

Unit 5, 79 Bourke Road, Alexandria NSW 2015 Australia Phone +61 2 9330 1700 Fax: +61 2 8338 9001
E-mail: sales@controldevices.net Visit: www.controldevices.net

Refer to the additional sheet for the location of the digital output bits specific to your joystick configuration.

9.4 Digital Input Objects

The following objects relate to the functionality of the digital inputs of the device, if available. Digital inputs are active low and the device has internal pull up resistors.

9.4.1 Index 0x5003: Debounce Time

The device provides debounce filtering for each digital input line so that pushbuttons and switches can be connected without external filtering. The duration of the debounce filter can be set individually for each input line. The value of each object is the filter time in milliseconds, a value of 0 will disable the filtering function.

Name	Index	Sub-index	Data Type	Access	PDO Mapping	Default Value
Number of Digital Input Lines	0x5003	0	Unsigned 8	RO	No	0x18
Filtering Time	0x5003	1 to 24	Unsigned 8	RW	No	40

Refer to the additional sheet for the location of the digital input bits specific to your joystick configuration.

Unit 5, 79 Bourke Road, Alexandria NSW 2015 Australia Phone +61 2 9330 1700 Fax: +61 2 8338 9001
E-mail: sales@controldevices.net Visit: www.controldevices.net

9.4.2 Index 0x6000: Read Digital Input

These objects represent the digital inputs. The first object, sub-index 0, returns the number of objects in the array. The second object, sub-index 1, returns the state of the internal flip-flops for each analogue input axis if the memory function is in use. Subsequent objects represent the digital inputs; the values of the objects are updated by the digital input lines. Input lines are active low, so a value of 1 in a bit of the input object represents a grounding of the input pin.

Name	Index	Sub-index	Data Type	Access	PDO Mapping	Default Value
Number of Objects in the Array	0x6000	0	Unsigned 8	RO	No	Depends on Operation Mode
Memory Function Status for Each Axis	0x6000	1	Unsigned 8	RO	Yes	-
Digital Input Byte 1	0x6000	2	Unsigned 8	RO	Yes	-
Digital Input Byte 2	0x6000	3	Unsigned 8	RO	Yes	-
Digital Input Byte 3	0x6000	4	Unsigned 8	RO	Yes	-

Refer to the additional sheet for the location of the digital input bits specific to your joystick configuration.

9.4.3 Index 0x6005: Global Interrupt Enable

This object enables or disables the global interrupt for the digital input. The global interrupt must be enabled to use an event driven PDO transmission type, see *9.2.1.3 Sub-index 2: Transmission Type* for more information. A value of 1 enables the global interrupt; a value of 0 disables the global interrupt.

Name	Index	Sub-index	Data Type	Access	PDO Mapping	Default Value
Global Interrupt Enable	0x6005	0	Unsigned 8	RW	No	0x01

Unit 5, 79 Bourke Road, Alexandria NSW 2015 Australia Phone +61 2 9330 1700 Fax: +61 2 8338 9001
E-mail: sales@controldevices.net Visit: www.controldevices.net

9.4.4 Index 0x6006: Interrupt Mask: Any Change

This array of objects enables or disables the interrupt for any change of each digital input. If enabled an interrupt will be triggered for any change on the digital input line; a value of 1 enables the interrupt on any change, a value of 0 will disable it. The first sub-index returns the number of objects in the array; subsequent sub-indexes define the interrupt mask for each digital input byte. The default value enables the interrupt on any change for all digital inputs.

Name	Index	Sub-index	Data Type	Access	PDO Mapping	Default Value
Number of Objects in the Array	0x6006	0	Unsigned 8	RO	No	Depends on Operation Mode
Digital Input Byte 1	0x6006	1	Unsigned 8	RW	No	0Xff
Digital Input Byte 2	0x6006	2	Unsigned 8	RW	No	0xff
Digital Input Byte 3	0x6006	3	Unsigned 8	RW	No	0xff

Refer to the additional sheet for the location of digital input bits specific to your joystick configuration.

9.4.5 Index 0x6007: Interrupt Mask: Rising Edge

This array has a similar function and structure to *9.4.4 Index 0x6006: Interrupt Mask: Any Change* but will only generate interrupts on the rising edge of the input. As the input becomes active an interrupt will trigger, as it becomes inactive an interrupt will not be triggered. The default value of the objects in the array is 0x00; interrupt on rising edge is disabled.

9.4.6 Index 0x6008: Interrupt Mask: Falling Edge

This array has a similar function and structure to *9.4.4 Index 0x6006: Interrupt Mask: Any Change* but will only generate interrupts on the falling edge of the input. As the input becomes inactive an interrupt will trigger, as it becomes active an interrupt will not be triggered. The default value of the objects in the array is 0x00; interrupt on falling edge is disabled.

9.5 Analogue Input Objects

The following objects relate to the functionality of the analogue inputs of the device.

9.5.1 Index 0x5401: Dead Band Value

This array of objects defines the dead band for each axis. The first sub-index returns the number of objects in the array; subsequent objects define the dead band value for each analogue input. If the analogue input is within the dead band (greater than the negative of the dead band value and less than the dead band value,) the value of *9.5.2 Index 0x6401: Read Analogue Input* for that input will be 0x0000. If the analogue input is less than the negative of the dead band value, the value of *9.5.2 Index 0x6401: Read Analogue Input* for that input will be the analogue input value plus the dead band value. Similarly, if the analogue input is greater than the dead band value, the value of *9.5.2*

Unit 5, 79 Bourke Road, Alexandria NSW 2015 Australia Phone +61 2 9330 1700 Fax: +61 2 8338 9001
E-mail: sales@controldevices.net Visit: www.controldevices.net

Index 0x6401: Read Analogue Input for that input will be the analogue input value minus the dead band value. The following table summarises the calculation to determine the value of the analogue input object:

Analogue Input Value	**Analogue Input Object**
$A_1 < -DB_1$ (Axis negative position)	$AO_1 = A_1 + DB_1$
$A_1 > -DB_1$ AND $A_1 < DB_1$ (Within dead band)	$AO_1 = 0x0000$
$A_1 > DB_1$ (Axis positive position)	$AO_1 = A_1 - DB_1$

The default value for each dead band object is 0x1000.

Name	**Index**	**Sub-index**	**Data Type**	**Access**	**PDO Mapping**	**Default Value**
Number of Objects in the Array	0x5401	0	Unsigned 8	RO	No	Number of Axes
Dead Band Value	0x5401	1 to Number of Axes	Unsigned 16	RW	No	0x1000

9.5.2 Index 0x6401: Read Analogue Input

This array contains objects to read each analogue input. The first sub-index contains the number of sub-indexes in the array; subsequent sub-indexes contain the result from the analogue input lines. The values of these objects are a signed 16 bit integer; a positive value corresponds to a positive position of the analogue input, a negative value corresponds to a negative position of the analogue input.

Name	**Index**	**Sub-index**	**Data Type**	**Access**	**PDO Mapping**	**Default Value**
Number of Objects in the Array	0x6401	0	Unsigned 8	RO	No	Number of Axes
Read Analogue Input	0x6401	1 to Number of Axes	Signed 16	RO	Yes	-

Refer to the additional sheet for the location of analogue input objects specific to your joystick configuration.

Unit 5, 79 Bourke Road, Alexandria NSW 2015 Australia Phone +61 2 9330 1700 Fax: +61 2 8338 9001
E-mail: sales@controldevices.net Visit: www.controldevices.net

9.5.3 Index 0x6421: Interrupt Trigger Type

This array contains objects to set the type of events that will trigger an interrupt for each analogue input. The first sub-index returns the number of sub-indexes in the array; subsequent sub-indexes contain a bitmap to set trigger types as show below:

Bit	Interrupt Trigger Type
0	Input voltage greater than Upper Limit
1	Input voltage less than Lower Limit
2	Input changed more than Delta
3	Input decreased more than Negative Delta
4	Input increased more than Positive Delta
5 to 7	Reserved (must be forced to 0)

The default value for each axis' interrupt trigger type is 7, which enables the first three interrupt trigger types. Limit values are defined in *9.5.5 Index 0x6424 to 0x6428: Interrupt Limits*.

Name	Index	Sub-index	Data Type	Access	PDO Mapping	Default Value
Number of Objects in the Array	0x6421	0	Unsigned 8	RO	No	Number of Axes
Interrupt Trigger Type	0x6421	1 to Number of Axes	Unsigned 8	RW	No	7

9.5.4 Index 0x6423: Global Interrupt Enable

This object controls the global interrupt for the analogue inputs. By default the interrupt is disabled to avoid excessive transmission of analogue input values. A value of 1 enables the global interrupt for the analogue input; a value of 0 will disable it.

Name	Index	Sub-index	Data Type	Access	PDO Mapping	Default Value
Global Interrupt Enable	0x6423	0	Unsigned 8	RW	No	0

Unit 5, 79 Bourke Road, Alexandria NSW 2015 Australia Phone +61 2 9330 1700 Fax: +61 2 8338 9001
E-mail: sales@controldevices.net Visit: www.controldevices.net

9.5.5 Index 0x6424 to 0x6428: Interrupt Limits

There a several arrays of objects to define interrupts limits, these objects all have an identical structure. The function of each array is:

Index	Name and Function
0x6424	Upper Limit Value – Generate interrupt if input voltage is greater than limit value.
0x6425	Lower Limit Value – Generate interrupt if input voltage is less than limit value.
0x6426	Delta Value – Generate interrupt if input voltage changes by more than delta value.
0x6427	Negative Delta Value – Generate interrupt if voltage reduced by more than negative delta value.
0x6428	Positive Delta Value – Generate interrupt if voltage increased by more than positive delta value.

The structure of each array is:

Name	Index	Sub-index	Data Type	Access	PDO Mapping	Default Value
Number of Objects in the Array	0x642_	0	Unsigned 8	RO	No	Number of Axes
Interrupt Trigger Type	0x642_	1 to Number of Axes	Signed 32	RW	No	0

9.5.6 Index 0x6431: Input Offset

This array contains objects to define the input offset for each axis. The input offset value is added to *9.5.2 Index 0x6401: Read Analogue Input*. By default the analogue input value is positive and negative with 0 at the centre, if only positive values are required an input offset of 0x8000 can be used.

Name	Index	Sub-index	Data Type	Access	PDO Mapping	Default Value
Number of Objects in the Array	0x6431	0	Unsigned 8	RO	No	Number of Axes
Input Offset	0x6431	1 to Number of Axes	Signed 32	RW	No	0

10 Emergency Messages

The device supports several emergency messages; the Object ID for these messages is 0x80 + Node ID. The structure of the message is:

Byte

Unit 5, 79 Bourke Road, Alexandria NSW 2015 Australia Phone +61 2 9330 1700 Fax: +61 2 8338 9001
E-mail: sales@controldevices.net Visit: www.controldevices.net

0	1	2	3	4	5	6	7
EMCY Code		Error Register	0	Device Error Code			

A description of each section is given below:

EMCY Code	Emergency error code according to DS310.
Error Register	The contents of the Error Register, index 0x1001.
Device Error Code	An unsigned 32 bit value to indicate error type.

A list of device error codes is given below:

Device Error Code	**Description**
0x80000000	CAN Bus in Bus Off state.
0x40000000	CAN Bus in error warning state.
0x30000000	Life Guarding error.

In the event of multiple errors the error codes are combined in a logical OR operation. Be aware that some error conditions can cause a change of NMT state and/or force output pins into their error state.

11 Example Usage Scenarios

11.1 Default Settings

The factory default settings will send a message on any change of the digital output, but no message will be sent on analogue input change. There are 2 analogue inputs (generally X and Y axis of the joystick,) and 24 digital inputs mapped into PDO objects. Refer to the additional sheet for the location of inputs specific to your joystick configuration.

Unit 5, 79 Bourke Road, Alexandria NSW 2015 Australia Phone +61 2 9330 1700 Fax: +61 2 8338 9001
E-mail: sales@controldevices.net Visit: www.controldevices.net

11.2 Send Message on Change

This configuration will send data on any change of the digital inputs and on any change of the analogue inputs, no more frequently than the inhibit time of 10 ms.

Operation	Index	Sub-index	Type	Value	Description
Write SDO	0x1011	1	u32	0x64616f6c	Load factory defaults; the following instructions assume you are starting from factory defaults. You will need to reset the device to complete the operation. See *9.1.9 Index 0x1011: Load Default Parameters*
Write SDO	0x1801	3	u16	0x64	Set Inhibit Time for analogue input PDO to 10 ms. See *9.2.1.4 Sub-index 3: Inhibit Time*
Write SDO	0x6423	0	u8	0x1	Enable global interrupt on analogue input. See *9.5.4 Index 0x6423: Global Interrupt Enable*
Write SDO	0x1010	1	u32	0x65766173	Save current configuration so that the configuration is maintained after the device is restarted. See *9.1.8 Index 0x1010: Save Parameters*
NMT Start					Set device to operational mode.

11.3 Send Message on Change and Periodically

In addition to the previous commands in *11.2 Send Message on Change* the following commands can be used to also send messages periodically, after the event time of 100 ms.

Operation	Index	Sub-index	Type	Value	Description
Write SDO	0x1800	5	u16	0x3EB	Set Event Time for digital input PDO to 100 ms. See *9.2.1.6 Sub-index 5: Event Time*
Write SDO	0x1801	5	u16	0x3EB	Set Event Time for analogue input PDO to 100 ms. See *9.2.1.6 Sub-index 5: Event Time*
Write SDO	0x1010	1	u32	0x65766173	Save current configuration so that the configuration is maintained after the device is restarted. See *9.1.8 Index 0x1010: Save Parameters*
NMT Start					Set device to operational mode.

Unit 5, 79 Bourke Road, Alexandria NSW 2015 Australia Phone +61 2 9330 1700 Fax: +61 2 8338 9001
E-mail: sales@controldevices.net Visit: www.controldevices.net

11.4 Send Message on Remote Transmission Request

This configuration with update and send data on reception of a Remote Transmission Request.

Operation	Index	Sub-index	Type	Value	Description
Write SDO	0x1011	1	u32	0x64616f6c	Load factory defaults; the following instructions assume you are starting from factory defaults. You will need to reset the device to complete the operation. See *9.1.9 Index 0x1011: Load Default Parameters*
Write SDO	0x1800	2	u8	0xFD	Set transmission type for digital input to Asynchronous RTR. See *9.2.1.3 Sub-index 2: Transmission Type*
Write SDO	0x1801	2	u8	0xFD	Set transmission type for analogue input to Asynchronous RTR. See *9.2.1.3 Sub-index 2: Transmission Type*
Write SDO	0x1010	1	u32	0x65766173	Save current configuration so that the configuration is maintained after the device is restarted. See *9.1.8 Index 0x1010: Save Parameters*
NMT Start					Set device to operational mode.

11.5 Send Message on Sync Signal

This configuration will send a message for each PDO every time a sync signal is received.

Operation	Index	Sub-index	Type	Value	Description
Write SDO	0x1011	1	u32	0x64616f6c	Load factory defaults; the following instructions assume you are starting from factory defaults. You will need to reset the device to complete the operation. See *9.1.9 Index 0x1011: Load Default Parameters*
Write SDO	0x1800	2	u8	0x01	Set transmission type for digital input to Cyclic Synchronous with a multiplier of 1. See *9.2.1.3 Sub-index 2: Transmission Type*
Write SDO	0x1801	2	u8	0x01	Set transmission type for analogue input to Cyclic Synchronous with a multiplier of 1. See *9.2.1.3 Sub-index 2: Transmission Type*
Write SDO	0x1010	1	u32	0x65766173	Save current configuration so that the configuration is maintained after the device is restarted. See *9.1.8 Index 0x1010: Save Parameters*
NMT Start					Set device to operational mode.

Unit 5, 79 Bourke Road, Alexandria NSW 2015 Australia Phone +61 2 9330 1700 Fax: +61 2 8338 9001
E-mail: sales@controldevices.net Visit: www.controldevices.net